MARCONI INSTRUMENTS

200 MHz DIGITAL FREQUENCY METER TF. 2431A

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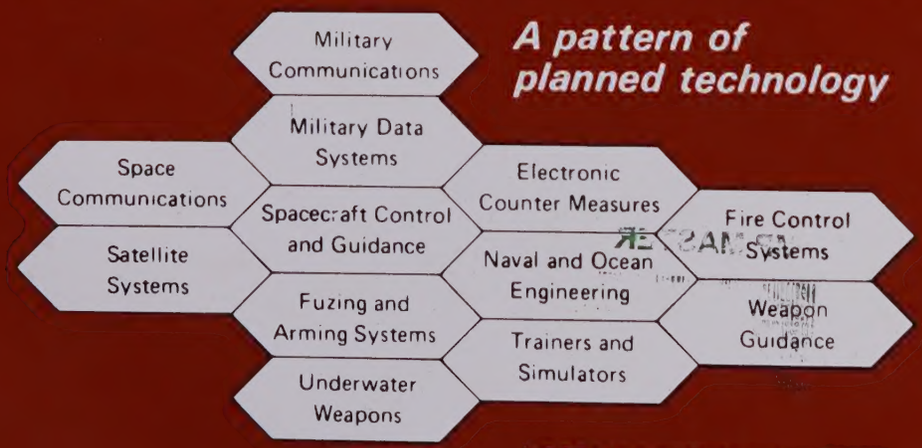
MA23658

Marconi Space and Defence Systems Limited



A pattern of planned technology

A GEC Marconi Electronics Company

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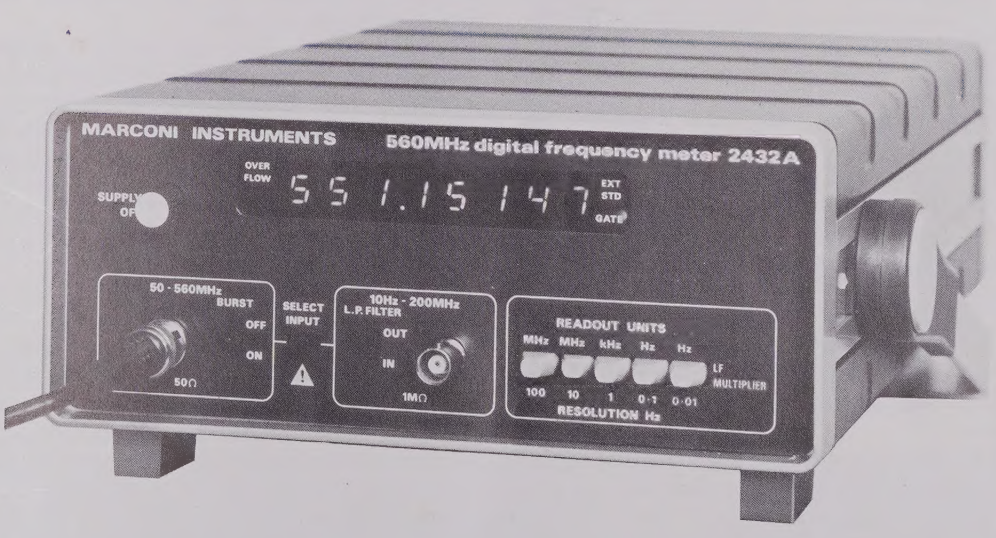
Digital Frequency Meter

2430A series

☐ 2430A; 10 Hz to 80 MHz ☐ 2431A; 10 Hz to 200 MHz ☐ 2432A; 10 Hz to 560 MHz ☐ Direct frequency measurement – resolution to 0·01 Hz ☐ Automatic gain control – wide dynamic range ☐ Choice of three internal frequency standards or external standard ☐ Burst mode of operation on 2432A ☐ Data interface option ☐ Excellent reliability and servicing accessibility – 2 year guarantee



Model 2432A *14741/12*

Digital frequency meters types 2430A, 2431A and 2432A are significantly improved versions of the successful TF 2430 series which they replace. These new models are high quality, high reliability, general purpose instruments providing direct frequency measurement over the range 10 Hz to 560 MHz.

Much of the circuitry is contained in a custom-designed MOS-LSI chip. CMOS and low power Shottky devices are also extensively used resulting in operational simplicity, reliability and low power consumption.

Features common to the range include a bright l.e.d. display with memory, automatic positioning of decimal point, overflow indication, leading zero suppression and a digit check facility. The instruments all have provision for operating with internal or external frequency standard.

Input channels

Models 2430A and 2431A both have single, high impedance inputs with frequency cover from 10 Hz to 80 MHz and 10 Hz to 200 MHz respectively. 2432A has

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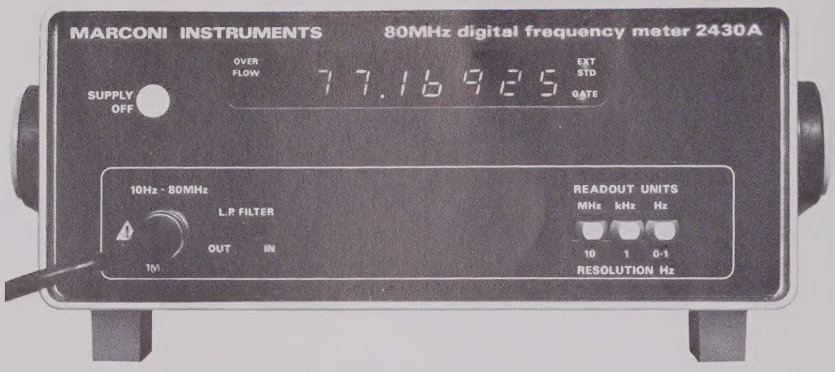
Digital Frequency Meter



Model 2430A *14741/7*

two separate inputs, selected by a front-panel switch. A high impedance input covers the frequency range 10 Hz to 200 MHz and a 50 Ω input covers the range 50 MHz to 560 MHz.

Automatic gain control on all inputs enables a wide range of signal levels to be accommodated without the need for a sensitivity control or manual attenuator. Sensitivity of 2430A is 25 mV r.m.s. and of the two higher frequency models is 10 mV r.m.s. The maximum signal input with which the frequency meters will operate satisfactorily is not less than 260 V r.m.s. at 50 Hz, reducing to 5 V r.m.s. at the highest frequencies. The 50 Ω high frequency input channel of 2432A is protected by a built-in r.f. fuse. Application of overload voltages up to 50 volts to this channel will result only in a blown fuse.

All models include a switchable low-pass input filter which reduces the sensitivity of the instruments at frequencies above 10 kHz. This is valuable when measuring audio frequencies in the presence of high frequency noise.

Model 2432A includes a frequency multiplier circuit to enhance further the low frequency performance. The multiplier produces an output frequency equal to 100 times the input frequency. This gives a resolution of 0·01 Hz in one second measurement time for input frequencies between 10 Hz and 5 kHz. This facility is very useful for fast and accurate measurements of audio frequencies such as amplifier response characteristics and calling tone measurements in paging instruments.

A useful 'burst' measurement mode is also incorporated in 2432A, permitting frequency measurements on any r.f. signals existing for only a short period of time. Normally the counter display is updated at the end of each measurement cycle and if the signal is removed the next display will be zero. In the burst mode, if the signal is removed the display will retain the previous reading indefinitely or until a signal is re-applied. This mode is useful for measuring transmitter carrier frequencies by brief operation of the 'transmit' switch.

Display

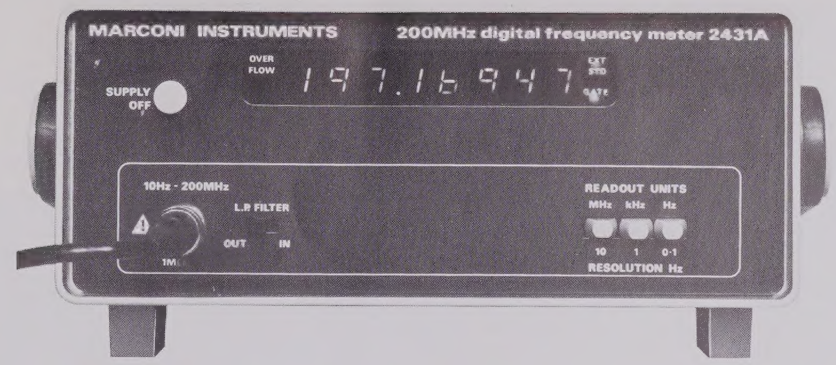
Frequency readout is by bright light emitting diode displays with memory – a seven-digit display in 2430A and an eight-digit display in the two higher frequency models. Characters are seven-segment and have a minimum height of 8 mm.

Readout units – MHz, kHz or Hz as appropriate – are indicated by front-panel markings adjacent to the gate-time push-buttons, and resolution in Hz is also indicated for each range. Decimal point positioning, overflow indication and leading zero suppression are all automatic. A digit check facility is also included whereby all the l.e.d. segments and all decimal points are displayed when all the gate-time buttons are simultaneously released.

Frequency standard

Options of the various instruments are available with three different frequency standards and there is provision on all models for operation with an external frequency. Two versions of 2430A offer either a standard crystal oscillator with a stability of ±5 in 10^6 over the operating temperature range, or a temperature compensated crystal oscillator with a stability of ±1·5 in 10^6. Model 2432A has a choice of the temperature compensated crystal oscillator or an oven-controlled crystal oscillator giving a stability of ±0·1 in 10^6 over the range. Model 2431A is available in all three versions. A control accessible through the rear panel of all models permits adjustment of the internal standard to compensate for crystal ageing.

There is provision on all models for operation with a 1 MHz external standard frequency applied via a rear-panel socket. Application of an external signal automatically overrides the internal oscillator and a front-panel lamp indicates when the external standard is in use. If the external standard fails or is removed, the instrument switches automatically to operation from the internal oscillator. This feature is valuable in automatic or remote set-ups where there is no access to the rear



Model 2431A *14741/10*

panel. The sensitivity and bandwidth versatility of the external input offer the possibility of ratio measurements by connecting one signal to the front panel input socket and the other signal to the external standard socket.

Data interface

All models can be fitted with an optional data output and programming interface, allowing the frequency meter to be used in conjunction with a printer or as part of an instrumentation system.

External control signals can set the frequency meter to remote, set the counter range, clear and trigger the count sequence and enable or disable the display.

The resulting frequency reading is available as serial b.c.d. data multiplexed into the interface by external synchronizing signals. Decimal point indication and suppressed leading zeros data are multiplexed simultaneously. Provision is included for single measurements by giving direct access to the main gate control circuitry.

The data interface kit consists of a 24 way connector which is fitted to the rear panel and a ribbon cable which links this connector to miniature sockets in the instrument. This kit can readily be fitted by the user.

Battery power unit

A version of 2432A is available with an attached rechargeable nickel cadmium battery pack providing a useful operation time of greater than $3\frac{1}{2}$ hours when fully charged. When the instrument is operated on mains supply it will switch automatically to battery operation if the mains supply fails. This ensures continuous operation where mains drop-out is a possibility. The battery unit includes a current-limited battery charger driven from the 2432A mainframe and this charger can be used when the frequency meter is fully operational. There is also facility for charging from an external 12 volt car battery. Recharging time to full capacity is approximately 14 hours at 700 mA. The battery pack cannot be damaged by indefinite overcharging.

Model 2432A in Rack Mounting Kit with optional accessories *14756*

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Digital Frequency Meter

Specification for the series

TYPE NUMBER	2430A	2431A	2432A
INPUT CHANNELS	Single Channel		Two channels, switch selected.
Frequency range	10 Hz to 80 MHz.	10 Hz to 200 MHz.	*LF INPUT:* 10 Hz to 200 MHz. *HF INPUT:* 50 MHz to 560 MHz.
Sensitivity	25 mV r.m.s. (sinewave).	10 mV r.m.s. (sinewave).	*LF INPUT:* 10 mV r.m.s. (sinewave) from 10 Hz to 70 MHz 25 mV r.m.s. (sinewave) from 70 MHz to 200 MHz. *HF INPUT:* 10 mV r.m.s. (sinewave) p.d. into 50 Ω.
	Built-in a.g.c. provides capability for handling signals automatically over a wide dynamic range.		
Dynamic range	80 dB.	90 dB.	*LF INPUT:* 90 dB. *HF INPUT:* 54 dB.
Maximum sinewave input	260 V r.m.s. at 50 Hz 5 V r.m.s. at 80 MHz Degradation from 50 Hz to 80 MHz is approximately 3×10^{-6} V/Hz.	260 V r.m.s. at 50 Hz 5 V r.m.s. at 200 MHz Degradation from 50 Hz to 200 MHz is approximately $1{\cdot}3 \times 10^{-6}$ V/Hz.	*LF INPUT:* 260 V r.m.s. at 50 Hz 5 V r.m.s. at 200 MHz. Degradation from 50 Hz to 200 MHz is approximately $1{\cdot}3 \times 10^{-6}$ V/Hz. *HF INPUT:* 5 V r.m.s. p.d. into 50 Ω from 50 MHz to 560 MHz.
Maximum d.c.	250 V.		*LF INPUT:* 250 V. *HF INPUT:* 5 V.
Maximum pk a.c. +d.c.	250 V at nominal 50 Hz.		*LF INPUT:* 250 V. *HF INPUT:* 5 V.
Input impedance	Approximately 1 MΩ in parallel with less than 25 pF AC coupled via 0·1 μF.		*LF INPUT:* Approximately 1 MΩ in parallel with less than 25 pF. AC coupled via 0·1 μF. *HF INPUT:* 50 Ω nominal.
Input filter	Switchable low pass filter reduces sensitivity above 10 kHz to improve noise immunity when counting LF signals (attenuation at least 20 dB above 100 kHz).		
MODES OF OPERATION			
Range selection	Three push-buttons select the following ranges and indicate the resolution and readout units. 100 ms gate time providing 10 Hz resolution 1 s gate time providing 1 Hz resolution 10 s gate time providing 0·1 Hz resolution All ranges operate over the full frequency range.		Five push-buttons select the following ranges and indicate the resolution and readout units. 10 ms gate time providing 100 Hz resolution 100 ms gate time providing 10 Hz resolution 1 s gate time providing 1 Hz resolution 10 s gate time providing 0·1 Hz resolution 1 s gate time providing 0·01 Hz resolution The first four ranges operate on both channels over the full frequency range. The last range operates only on the LF channel up to 5 kHz.
Burst mode			A push-button selects a burst mode on the HF channel only. The display then retains the reading indefinitely after the input signal is removed. The signal must be present for at least twice the gate time plus 200 ms.

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2430A series

DISPLAY	Seven digit with memory	Eight digit with memory	
	Seven segment LEDs of 8 mm height		
Features	Decimal point automatically selected. Overflow indication. Leading zeros suppressed. Digit check facility—releasing all range buttons displays all l.e.d. segments and decimal points.		
Display time	Readout retained during gating period.		
Gate indication	Lamp indicates gating period.		
ACCURACY	±1 count ± stability of frequency standard.		
FREQUENCY STANDARD	Internal crystal oscillator or external input automatically selected. Application of external signal overrides the internal oscillator. A front panel lamp indicates when the external standard is in operation. A control accessible through the rear panel allows adjustment of the internal standard to compensate for ageing.		
INTERNAL CRYSTAL OSCILLATOR	Model 52430–311H	Model 52431–311S	
Temperature stability	Better than ±5 p.p.m. over the operating temperature range of 0° to 40°C.		
Ageing rate	Better than ±0·8 p.p.m. nominal per month after 1 month continuous use.		
TEMPERATURE COMPENSATED CRYSTAL OSCILLATOR	Model 52430–312E	Model 52431–312W	Model 52432–312A
Temperature stability	Better than ±1·5 p.p.m. over the operating temperature range of 0° to 40°C.		
Ageing rate	Better than ±0·4 p.p.m. nominal per month after 1 month continuous use.		
OVEN CONTROLLED CRYSTAL OSCILLATOR		Model 52431–313D	Model 52432–313Z
Temperature stability		Better than ±0·1 p.p.m. over the operating temperature range of 0° to 40°C	
Ageing rate		Better than ±0·4 p.p.m. nominal per month after 1 month continuous use.	
AUXILIARY OUTPUT			
Frequency	Internal standard 1 MHz available from rear panel socket.		
Level	Greater than 100 mV p-p into 50 Ω (approximately 4 V p-p e.m.f.).		
Impedance	Approximately 2 kΩ.		
EXTERNAL FREQUENCY STANDARD			
Frequency	1 MHz sinewave or squarewave. Usable from 10 kHz to 1 MHz for ratio measurements.		
Input level	2·5 V to 5·5 V p.p.		100 mV minimum up to approximately 10 V maximum.
Input impedance	Approximately 300 Ω a.c. coupled.		Approximately 100 kΩ a.c. coupled.

DATA INTERFACE

BCD data output and remote range selection are available using the optional data output lead. This lead, which can be installed by the user, provides the following connexions.

Mnemonic	Function
ABCD, BBCD, CBCD, DBCD	BCD data output, bit parallel, byte serial.
DEN	Display enable input.
OFL	Overflow indication output.
NCLR	Counter and display clear input.
NINH	Counter control – may be used as an output to monitor gate or as an input to control gate.
SCX	External display scan unit – also controls data output multiplexing.
SCR	Internal/external multiplexing switch and multiplexer reset input.
DPT	Decimal point output.
LZS	Leading zeros suppression output.
ATB, BTB, CTB	1 of 3 range selection input.
NREM	Remote operation enable input.

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Digital Frequency Meter

TYPE NUMBER	2430A	2431A	2432A
RADIO FREQUENCY INTERFERENCE	Conforms with the requirements of EEC Directive 76/889 as to limits of r.f. interference.		
SAFETY	Complies with IEC 348.		
OPERATING TEMPERATURE RANGE			
Rated range of use	0° to 40°C		
Limit range of operation	0° to 55°C		0° to 55°C 0° to 50°C (with battery unit)
CONDITIONS OF STORAGE AND TRANSPORT			
Temperature	−40° to +70°C		−40°C to +70°C −40°C to +50°C (with battery unit)
Humidity	Up to 90% relative humidity.		
Altitude	Up to 2500 m (pressurised freight at 27 kN/m² differential, i.e. 3·9 lbf/in²).		
POWER REQUIREMENTS			
AC supply	Switchable voltage ranges: 95 to 120 V, 105 to 132V, 190 to 240 V, 210 to 264 V. 45 to 440 Hz.		
	10 VA approximately		15 VA approximately
Battery			(Model 52432–314H only) **Type:** Fully sealed NiCd battery pack. **Voltage:** 6 V nominal. **Capacity:** Sufficient for minimum of three hours (typically five hours) of continuous operation at a charging and operating temperature of 20°C. A front panel lamp indicates when the battery is approximately 90% discharged. **Recharging time:** Approximately fifteen hours to charge fully a discharged battery when in the 'charge' mode. **External charge:** Rear panel switch and terminals allow the battery to be charged from an external d.c. source in the range 10 to 14 V. The maximum current required is 700 mA.
Modes of operation			Three modes are selected by front panel push-buttons. **Off:** If the a.c. supply is connected the frequency meter operates normally and the battery receives a trickle charge. **On/standby:** If the a.c. supply is connected the frequency meter operates normally and the battery receives a trickle charge. If the a.c. supply is removed the battery supplies power. A front panel lamp indicates when the instrument is operating on battery power. **Charge:** If the a.c. supply is connected the frequency meter operates normally and the battery receives a fast charge. A front panel lamp indicates when the charge mode is selected.

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2430A series

DIMENSIONS			
Height	108 mm 4·25 in		108 mm 4·25 in 153 mm 6·0 in (with battery unit)
Width	256 mm 10·1 in		256 mm 10·1 in
Depth	338 mm 13·3 in		338 mm 13·3 in
Weight	2·2 kg 4·85 lb		4·0 kg 8·8 lb 7·0 kg 15·4 lb (with battery unit)
VERSIONS			
Ordering number and description	**52430–311H** 80 MHz Digital Frequency Meter 2430A with standard crystal oscillator. **52430–312E** 80 MHz Digital Frequency Meter 2430A with temperature compensated crystal oscillator.	**52431–311S** 200 MHz Digital Frequency Meter 2431A with standard crystal oscillator. **52431–312W** 200 MHz Digital Frequency Meter 2431A with temperature compensated crystal oscillator. **52431–313D** 200 MHz Digital Frequency Meter 2431A with oven controlled crystal oscillator.	**52432–312A** 560 MHz Digital Frequency Meter 2432A with temperature compensated crystal oscillator. **52432–313Z** 560 MHz Digital Frequency Meter 2432A with oven controlled crystal oscillator. **52432–314H** 560 MHz Digital Frequency Meter 2432A with temperature compensated crystal oscillator and with battery unit.
SUPPLIED ACCESSORIES	Mains Lead 43123–076Y Operating Manual		
OPTIONAL ACCESSORIES	46883–401T 46883–405C 43126–012S 54124–022L 54431–021B 46881–351F 46881–353V 46881–355W	Rack Mounting Kit (for all models except 52432–314H) Data Interface Kit BNC to BNC Lead, 1·5 m, 50 Ω Cover Assembly (storage) 20 dB, 20 W Attenuator (for 2432A only) Service Manual for 2430A series Service Manual for 2431A series Service Manual for 2432A series	

Printed in England (R)

This document gives only a general description of the product(s) and shall not form part of any contract. From time to time changes may be made in the products or in the conditions of supply.

200 MHz Digital Frequency Meter 2431A

Code Nos. 52431-311S, 312W and 313D

AMENDMENT RECORD

The following amendments are incorporated in this manual.

Amendment No.	Date	Applies to Ser. Nos. commencing

©
1979

MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND

Part no. 46881-351F
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5 Maintenance
6 Replaceable parts
7 Servicing diagrams

These chapters are contained in Vol. 1 Operating Manual

HAZARD WARNING SYMBOLS

The following symbols appear on the equipment and may be repeated on diagrams.

SYMBOL	TYPE OF HAZARD	REFERENCE IN MANUAL
⚠	Input voltage limit	See operating manual
⚠	AC supply switches setting	
⚠	Static sensitive device	Prelim page (iv) and Chaps. 5, 6 and 7.

NOTES AND CAUTIONS

ELECTRICAL SAFETY PRECAUTIONS

This equipment is protected in accordance with IEC Safety Class 1. It has been designed and tested according to IEC Publication 348, 'Safety Requirements for Electronic Measuring Apparatus', and has been supplied in a safe condition. The following precautions must be observed by the user to ensure safe operation and to retain the equipment in a safe condition.

Defects and abnormal stresses

Whenever it is likely that protection has been impaired, for example as a result of damage caused by severe conditions of transport or storage, the equipment shall be made inoperative and be secured against any unintended operation.

Removal of covers

Removal of the covers is likely to expose live parts although reasonable precautions have been taken in the design of the equipment to shield such parts. The equipment shall be disconnected from the supply before carrying out any adjustment, replacement or maintenance and repair during which the equipment shall be opened. If any adjustment, maintenance or repair under voltage is inevitable it shall only be carried out by a skilled person who is aware of the hazard involved.

Note that capacitors inside the equipment may still be charged when the equipment has been disconnected from the supply. Before carrying out any work inside the equipment, capacitors connected to high voltage points should be discharged; to discharge mains filter capacitors, if fitted, short together the L (live) and N (neutral) pins of the mains plug.

Mains plug

The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension lead without protective conductor. Any interruption of the protective conductor inside or outside the equipment is likely to make the equipment dangerous.

Fuses

Note that there is a supply fuse in both the live and neutral wires of the supply lead. If only one of these fuses should rupture, certain parts of the equipment could remain at supply potential.

To provide protection against breakdown of the supply lead, its connectors, and filter where fitted, an external supply fuse (e.g. fitted in the connecting plug) should be used in the live lead. The fuse should have a continuous rating not exceeding 6 A.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders shall be avoided.

RADIO FREQUENCY INTERFERENCE

This equipment conforms with the requirements of IEC Directive 76/889 as to limits of r.f. interference.

WARNING : HANDLING HAZARDS

This equipment is formed from metal pressings and although every endeavour has been made to remove sharp points and edges care should be taken, particularly when servicing the equipment, to avoid minor cuts.

WARNING : TOXIC HAZARD

Many of the electronic components used in this equipment employ resins and other chemicals which give off toxic fumes on incineration. Appropriate precautions should therefore be taken in the disposal of these items.

CAUTION : STATIC SENSITIVE COMPONENTS

Components identified with the symbol on the circuit diagrams and/or parts lists are static sensitive devices. The presence of such devices is also indicated in the equipment by orange discs, flags or labels bearing the same symbol. Certain handling precautions must be observed to prevent these components being permanently damaged by static charges or fast surges.

(1) If a printed board containing static sensitive components (as indicated by a warning disc or flag) is removed, it must be temporarily stored in a conductive plastic bag.

(2) If a static sensitive component is to be removed or replaced the following anti-static equipment must be used.

A work bench with an earthed conductive surface.

Metallic tools earthed either permanently or by repeated discharges.

A low-voltage earthed soldering iron.

An earthed wrist strap and a conductive earthed seat cover for the operator, whose outer clothing must not be of man-made fibre.

(3) As a general precaution, avoid touching the leads of a static sensitive component. When handling a new one, leave it in its conducting mount until it is required for use.

Chapter 4-2

TECHNICAL DESCRIPTION

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8 Timing generator
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INTRODUCTION

1. The 2431A is available in three versions, which differ only in the stability of their frequency standards. A standard crystal oscillator is fitted to Version 52431-311S. A temperature compensated crystal oscillator frequency standard provides higher stability for Version no. 52431-312W. Highest stability is obtained by an oven controlled crystal oscillator frequency standard incorporated in Version no. 52431-313D.

2. A simplified block diagram of the frequency meter is shown in Fig. 1. Interconnection wiring details are shown in Chap. 7, Fig. 1. Circuit diagram references are included with the following descriptions.

INPUT AMPLIFIER, GATE AND HIGH SPEED DECADES

Circuit diagram : Chap.7, Fig. 3

3. The input signal is fed into an input buffer comprising a dual gate m.o.s. f.e.t. and emitter follower whose gain and, for high level signals, attenuation can be controlled by a d.c. voltage applied to the m.o.s. f.e.t. The output of the subsequent wide band amplifier is detected and converted into a proportional d.c. voltage which controls the buffer.

4. The output signal from this wide band amplifier is of constant amplitude and its level just exceeds the hysteresis window of the Schmitt trigger, thus ensuring reliable triggering

even when the signal has a poor signal-to-noise ratio. The square wave from the Schmitt trigger is applied to one input of an i.c. gate and is gated by a signal whose duration is precisely controlled. The pulse train from the main gate is counted by an eight decade counter, two and a half decades of which are discrete i.c.'s and the remainder part of a custom designed l.s.i. m.o.s. i.c.

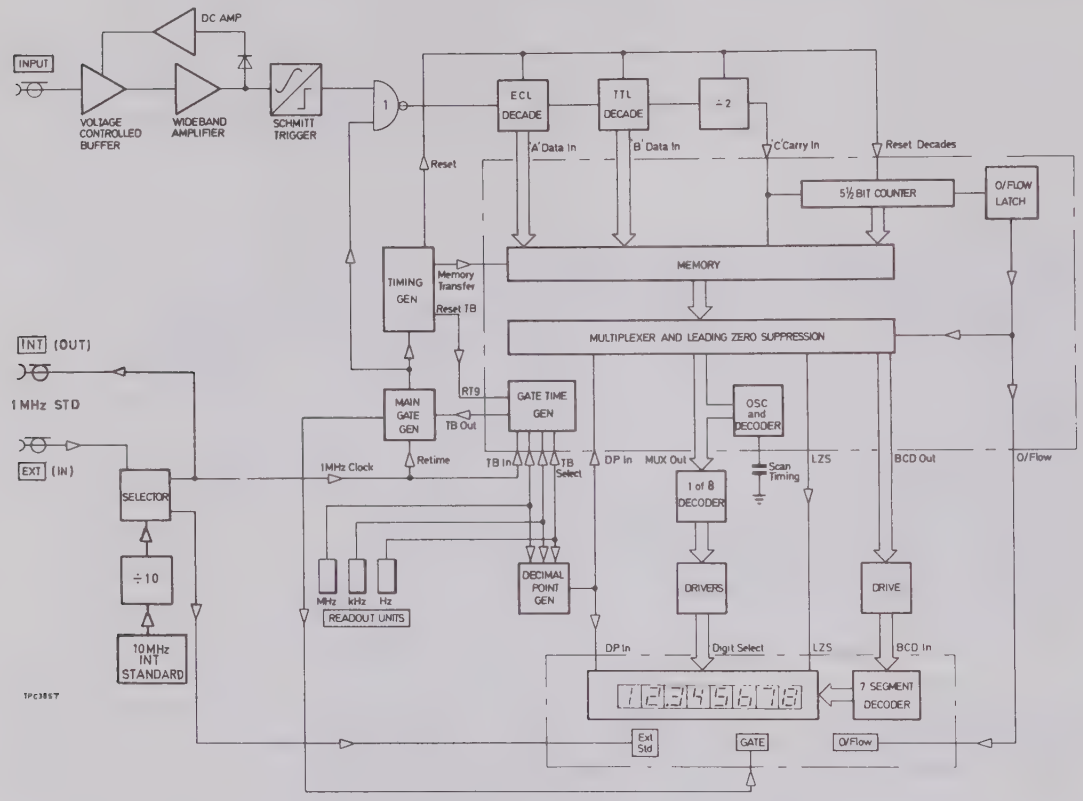

Fig. 1 2431A block diagram.

REFERENCE CLOCK SELECTION AND GATE GENERATOR

Circuit diagram : Chap. 7, Fig. 3

5. An internal 10 MHz crystal oscillator, frequency divided by 10, generates the counter 1 MHz main reference clock. This can alternately be introduced by a 1 MHz source via the EXT STD IN socket, which will automatically override the internal standard.

6. The 1 MHz clock is fed into the m.o.s. i.c. and divided down by the selected ratio, the maximum being 10^7.

7. The time base output is divided by two and retimed with the original 1 MHz clock signal before being applied to the main gate.

TIMING GENERATOR

Circuit diagram : Chap. 7, Fig. 3

8. TTL monostable integrated circuits generate a timing sequence which determines the display time, memory transfer and reset times. Waveform diagrams which show the timing sequences are illustrated in Fig. 2.

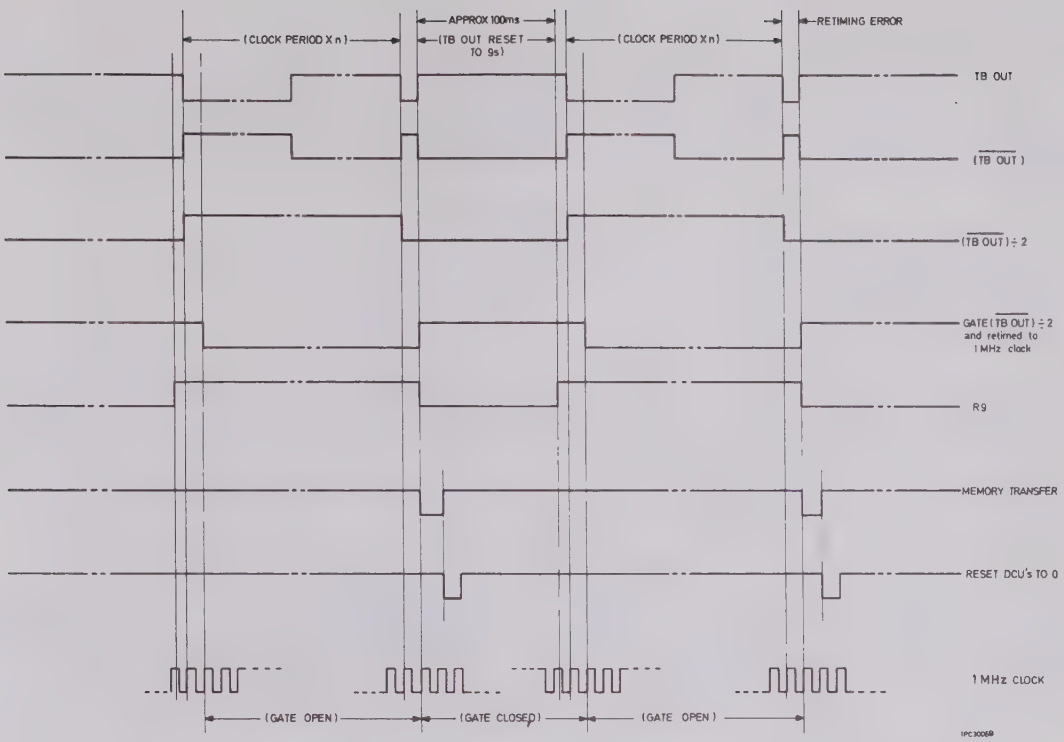

Fig. 2 Timing sequences.

LOGIC CIRCUIT

Circuit diagram : Chap. 7, Fig. 3

9. A custom designed l.s.i. m.o.s. integrated circuit is the heart of the counter and contains all the digital logic that does not need to run at high currents or speeds.

10. The i.c. contains a $5\frac{1}{2}$ decade counter with overflow latch and an eight decade memory. Two and a half decades of the memory have a parallel data loading capability to enable the i.c. to be used with higher speed logic. The data from the memories are fed into a multiplexer which is controlled by an on-chip oscillator and 1 of 8 encoder. A signal for providing leading zero suppression is generated in the i.c. The 40 pin package also contains a time base section comprising a decade divider and a 1 of 7 data selector.

SWITCHING

Circuit diagram : Chap. 7, Fig. 3

11. Front panel push button switches select one of three gate times. The 100 ms 1 s or 10 s gates describe the display resolution, units and decimal point position.

DISPLAY

Circuit diagram : Chap. 7, Fig. 5

12. The display board contains the 7 segment l.e.d. displays and b.c.d. to 7 segment encoder with its associated current limiting resistors. The board requires 1 of 8 digit drive, multiplexed b.c.d. information, a decimal point signal and leading zero suppression signal. Three lamps are mounted on this board indicating GATE, OVERFLOW and EXTERNAL STANDARD

operation.

LOW-PASS FILTER

Circuit diagram : Chap. 7, Fig. 3

13. A front panel slider switch selects a low-pass filter at the input stage. This reduces the sensitivity above 10 kHz, improving the noise immunity when counting low frequency signals.

10 MHz CRYSTAL OSCILLATOR

Standard version (52431-311S)

Circuit diagram : Chap. 7, Fig. 7

14. The normal stability standard crystal oscillator consists of an AT cut crystal used in a parallel resonance mode. Frequency adjustment is made either by capacitise trimmer or an external voltage applied to a varactor diode.

Temperature compensated version (52431-312W)

15. The crystal, manufactured to exhibit a near linear negative frequency/temperature coefficient over the temperature range is used in a parallel resonance mode. Compensation is effected by applying a voltage to a varactor diode that opposes the temperature coefficient of the crystal. The compensating voltage is determined by a resistor/thermistor network whose exact characteristics are determined by computer optimization techniques.

Oven controlled version (52431-313D)

16. The AT cut crystal used is operated at the inversion point on its frequency/temperature curve at a temperature of approximately 75°C. The temperature of the crystal is maintained within ±0.2°C by a thermistor bridge.

POWER SUPPLIES

Circuit diagram : Chap. 7, Figs. 1 and 3

17. A mains transformer with primary tappings variable to suit the mains supply available has three secondary windings feeding the d.c. supply circuits. These provide regulated +5.1 V, +12 V and -12 V lines.

Chapter 5

MAINTENANCE

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INTRODUCTION

1. This chapter contains information for maintaining the equipment in good working order, checking its overall performance and details adjustment procedures that may be necessary after replacement of components. Before attempting any maintenance, the information given should be read with reference to the preceding Technical Description chapter.

2. The only part of the instrument which should need regular attention is the 10 MHz oscillator. This should be periodically checked to ensure that it is operating at the correct frequency, and adjusted to offset any aging drift that has taken place. (see para. 17).

3. Integrated circuits and semiconductor devices are used throughout this instrument, and although these have inherent long term reliability and mechanical ruggedness, they are susceptible to damage by overloading, reversed polarity and excessive heat or radiation. Avoid hazards such as prolonged soldering, strong r.f. fields or other forms of radiation, the use of insulation testers or accidentally applied short circuits.

4. Static sensitive components ⚠. The c.m.o.s. integrated circuits used in this instrument have extremely high input resistance and can be damaged by accumulation of static charges. (see preliminary pages, Notes and Cautions).

ACCESS AND LAYOUT

Fuses

5. The frequency meter is protected by fuses in both the line and neutral conductors of the mains supply. Access is by means of screw caps on the rear panel.

Removing covers

6. The cover is retained by two screws at the back of the instrument. These screws also hold the protective foot and clamp assemblies and their removal allows the case to be slid backwards over the rear panel. The separation of instrument and case is best achieved with the instrument upside down.

Internal layout

7. Fig. 1 shows the general layout of the instrument with the transformer support chassis hinged up. Component layout illustrations of the function, display and standard crystal oscillator printed circuit boards are contained in Chap. 7.

Power supply

8. TR1 and TR2 the +5.1 V and +12 V line regulators, are mounted on the instrument back panel with their connections wired directly to the function board circuits. The remaining power supply components are contained on the function board below the transformer support chassis. Access to these can be gained by hinging the support chassis forward into a vertical position.

9. This is done by removing the two chassis retaining screws on the back panel and the rear two screws holding the chassis to the side frames. The remaining side frame screws should then be slackened, so that the chassis may hinge about them, and tightened to hold it in a convenient position. No electrical connections need to be removed.

Display board

10. The display board can be removed by lightly pushing the top edge away from the front panel, until the retaining bushes come clear of the panel support, and then lifting the board from the edge connector.

Amplifier buffer

11. The high impedance input buffer circuit with a metal screen fitted above and below, is contained on the function board near the input socket. To remove the screens proceed as follows :-

(1) Switch off the instrument.

(2) Turn the instrument upside down and remove the four screen retaining screws. Remove the screen.

(3) Turn the instrument right way up and remove the display board.

(4) Remove the retaining screw at the top front end of the screen. Remove the screen.

(5) Refit the display board.

PERFORMANCE TESTS AND ADJUSTMENTS

12. The tests in this section are simplified and of restricted range compared with those which

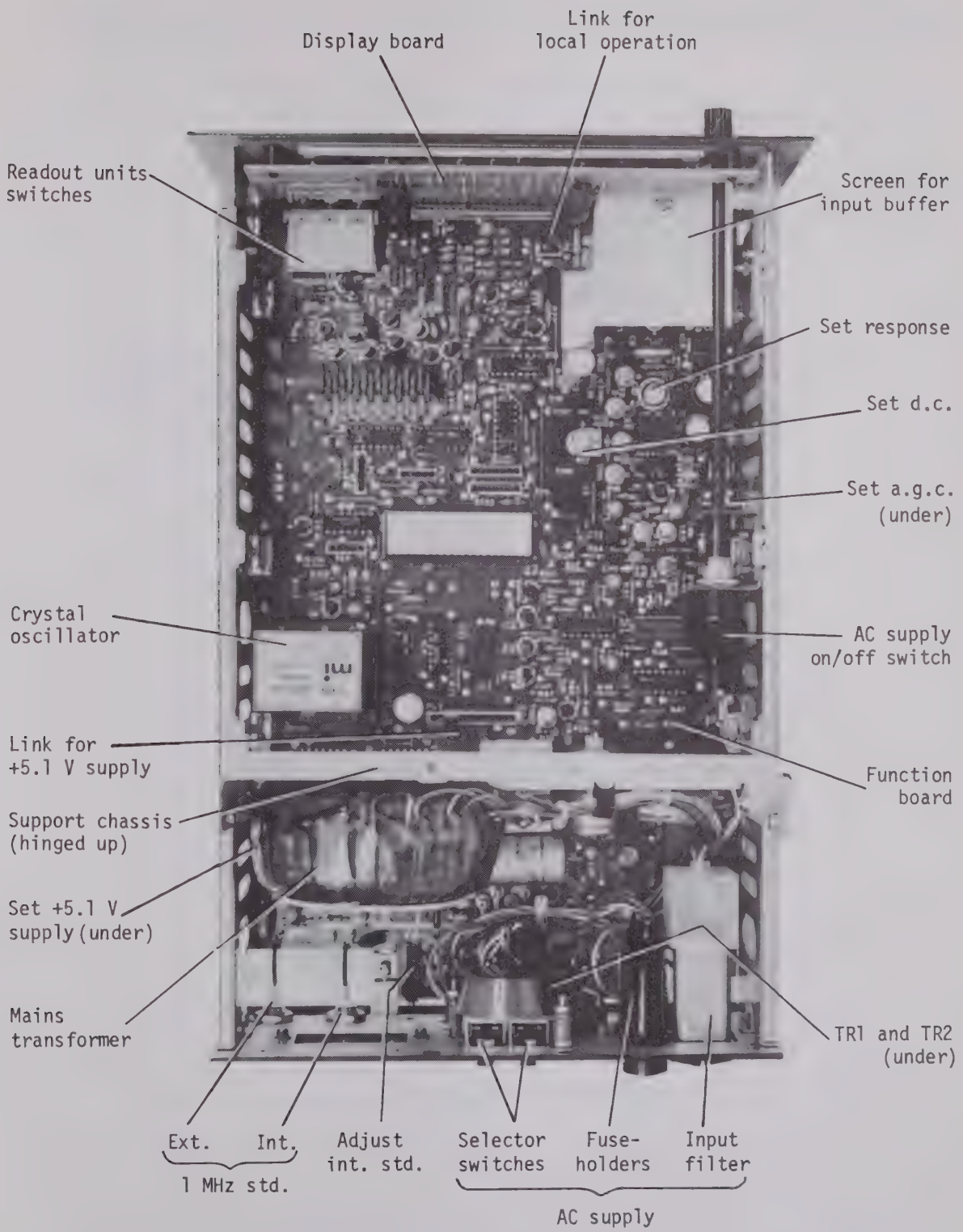

Fig. 1 2431A internal top view.

would be needed to demonstrate complete compliance with the specification. They should be regarded only as providing a check procedure, for use during routine maintenance, to determine whether adjustment or repair is necessary.

13. The performance limits quoted are for guidance and should not be taken as guaranteed performance specifications unless they are also quoted in the Performance Data in Chap. 1 (Vol. 1).

14. When making tests to verify that the instrument meets the stated performance limits, allowance must always be made for the uncertainty of the test equipment used.

15. In case of difficulties which cannot be resolved with the aid of this manual, please contact our Service Division at the address given on the rear cover, or your nearest Marconi Instruments representative. Always quote the type or model number and serial number found on the label at the rear of the instrument.

TABLE 1 TEST EQUIPMENT

Item	Description	Recommended model (Marconi Instruments unless otherwise stated)
a	1 MHz ±0.1 Hz frequency source	Derived from an off air standard frequencey source
b	10 MHz ±0.1 Hz frequency source	
c	10 Hz & 100 kHz signal source	2104
d	LF millivoltmeter with T connector	2600B
e	200 MHz signal source	2015
f	RF millivoltmeter with coaxial T connector	2603
g	1 MHz oscilloscope	
h	Sweep generator (range 10 Hz to 250 MHz)	Wavetek 2001
i	RF detector and probe (range 10 Hz to 250 MHz)	Wavetek D152
j	Display unit	2212A
k	Digital multimeter ranges : 0 - 20 V a.c. 0 - 15 V d.c. accuracy : better than ±0.2%	

Sensitivity

Test equipment : items a, c, d, e and f

16. Check that the frequency meter operates correctly with a 10 mV input at the low and high limits of the frequency range as follows :-

16.1 Low limit

(1) Connect the accurately known 1 MHz standard frequency signal to the EXT STD input socket. Level to be within 2.5 V to 5.5 V p-p.

CAUTION

EXT STD input voltage must not exceed 5.5 V p-p.

(2) Connect the 10 Hz signal source to the frequency meter input via the T connector and monitor level with the l.f. millivoltmeter at the input socket. Adjust input level to 10 mV r.m.s. (sine wave).

(3) Check EXT STD indicator is lit.

(4) Select Hz READOUT UNITS (Gate indicator flashes at 10 s intervals).

(5) Check counter indicates correctly.

16.2 High limit

(6) Change input frequency to 200 MHz and monitor level via the T connector and the r.f. millivoltmeter at the input socket. Adjust input level to 10 mV r.m.s. (sine wave).

(7) Select MHz READOUT UNITS (Gate indicator flashes ten times a second).

(8) Check counter indicates correctly.

(9) Select kHz READOUT UNITS and check that OVERFLOW indicator lights.

Internal standard frequency

Test equipment : item b

17. The accuracy of the internal 10 MHz standard frequency can be checked by comparing it with an accurately known external frequency as follows :-

(1) Disconnect the EXT STD input.

(2) Connect a known external frequency to the frequency meter input socket and select kHz READOUT UNITS. The value of the frequency is unimportant although higher frequency allows greater discrimination. A suggested frequency is 10 MHz, set to within ±0.1 Hz.

(3) Check counter indicates the correct frequency within ±1 Hz. If necessary fine adjustment of the internal standard frequency can be made to achieve the correct indication. This is done by means of the ADJUST INT STD control (R52) at the rear panel.

18. If the amount of adjustment required is outside the range of this fine control, centralize control and adjust the coarse control A10C2 on the oscillator unit to bring within range. Access to this preset variable capacitor is obtained by removal of the instrument case.

19. Access to this coarse control on the temperature compensated or oven controlled oscillator version is gained by removal of the clip-on oscillator unit cover. Allow time for temperature to stabilize before making adjustment. If a fault is diagnosed in either of these two units, do not attempt to repair but replace complete assembly (see Chap. 6).

Internal standard output

Test equipment : item g

20. The internal 10 MHz standard frequency is divided by 10 and made available at the rear panel. Check the output level as follows :-

(1) Connect the INT STD output socket on the rear panel to the 1 MHz oscilloscope terminated with 50 Ω.

(2) Check amplitude of 1 MHz oscillation is greater than 100 mV p-p (approx. 4 V e.m.f.).

Amplifier adjustments

Test equipment : items g, h, i and j

21. The following adjustment procedures should only be undertaken if repairs have been carried out to the amplifier circuit.

21.1 Set d.c.
(1) Select MHz READOUT UNITS.
(2) Turn R17 (set d.c.) fully anti-clockwise.
(3) Adjust R17 slowly clockwise until display just reads 0 in the least significant digit.

21.2 Set a.g.c.
(1) Monitor pin 6 of IC6 (a.g.c. drive) with the oscilloscope.
(2) Set oscilloscope to 2 V /cm, d.c. coupled.
(3) Adjust R69 so that voltage on pin 6 is + 6 V d.c.

21.3 Set response
(1) Connect the output of the sweep generator, set to sweep 10 Hz to 250 MHz to the frequency meter input socket.
(2) Connect the r.f. detector, via the high impedance probe to the junction D6/R20 (amplifier output).
(3) Feed detector output to the display unit.
(4) Adjust C10 to optimize the response in accordance with the following :-

a) The amplitude of the response is less important than the overall shape (see Fig. 2).
b) There must be no sharp peaks in the response.
c) The amplifier must not be on the verge of oscillation (shown by a tendency for the trace to break up.)

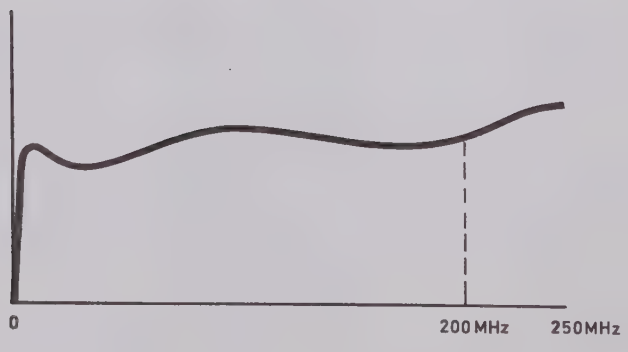

Fig. 2 Typical amplifier response.

Low-pass filter

Test equipment : items c and d

22. The low-pass filter attenuates input frequencies above 100 kHz by at least 20 dB. Check as follows :-

(1) Switch low-pass filter OUT.

(2) Connect the 100 kHz signal source to the frequency meter input via the T connector and monitor with the l.f. millivoltmeter.

(3) Determine the minimum level at which the frequency meter just counts the 100 kHz signal correctly.

(4) Switch the low-pass filter IN.

(5) Determine again the minimum level at which the frequency meter just counts the 100 kHz signal correctly.

(6) The difference between the two levels should be at least 20 dB.

Power supply

Test equipment : item k

23. The link between pins 3 and 4 on PLF can be removed to isolate the +5.1 V supply line from the counter circuits. Adjustment of the preset variable R160 should be carried out with this link in position, i.e. with load on supply.

24. The following voltages are given as a guide to the correct working voltages of the transformer secondaries and d.c. supply circuits.

Mains input supply		:	230 to 240 V a.c.
Sec 1		:	7.4 V to 8.4 V a.c.
Sec 3		:	14 V to 16 V a.c.
Sec 4		:	14 V to 16 V a.c.
Crystal oscillator unit pin 3	(+5.1 V line)	:	+5.10 V to +5.12 V d.c. (set with R160)
Crystal oscillator unit pin 4	(+12 V line)	:	+11 V to +13 V d.c.
A1, L2	(-12 V line)	:	-11V to -13 V d.c.

Chapter 6

REPLACEABLE PARTS

CONTENTS

Para.
1 Introduction
3 Abbreviations
4 Component values
6 Ordering
7 Components
7 Unit A0 Chassis assembly
8 Unit A1 Function board
9 Unit A2 Display board
10 Unit A10 Oscillator
11 Unit A11 Oscillator
12 Unit A12 Oscillator
13 Miscellaneous mechanical parts

Fig. Page
1 Miscellaneous mechanical parts : identification 12

INTRODUCTION

1. Each sub-assembly or printed circuit board in this instrument has been allocated a unit identification, e.g. A0, A1, A2 etc.

2. The complete component reference carries its unit number as a prefix, e.g. A1 C1 (capacitor C1 on board A1) but for convenience in the text and on circuit diagrams the prefix is not used. However, when ordering replacements or in correspondence the complete component reference must be quoted.

ABBREVIATIONS

3. The components are listed in alphanumerical order of the complete circuit reference and the following abbreviations are used :

C : capacitor
Carb : carbon
Cer : ceramic
D : semiconductor diode
Elec : electrolytic
FS : fuse
IC : integrated circuit (package)
L : inductor
LP : lamp l.e.d.
Pl : plug
Plas : plastic dielectric
R : resistor
Rect : rectifier bridge
S : switch
SK : socket
T : transformer
Tant : tantalum
TR : transistor
Var : variable
W : watts at 70°C
WW : wirewound
XL : crystal
† : value selected during test; nominal value listed
⚠ : static sensitive component

COMPONENT VALUES

4. One or more of the components fitted in this instrument may differ from those listed in this chapter for any of the following reasons :

(a) Components indicated by a † have their values selected during test to achieve particular performance limits.

(b) Owing to supply difficulties, components of different value or type may be substituted provided the overall performance of the instrument is maintained.

(c) As part of a policy of continuous development, components may be changed in value or type to obtain detail improvements in performance.

5. When there is a difference between the component fitted and the one listed, always use as a replacement the same type and value as found in the instrument.

ORDERING

6. When ordering replacements, address the order to our Service Division (address on rear cover) or nearest agent and specify the following for each component required :

(1) Type* and serial number of instrument.

(2) Complete circuit reference.

(3) Description.

(4) MI code number.

*As given on the serial number label at the rear of the instrument; if this is superseded by a model number label, quote the model number instead of the type number.

Circuit reference	Description	Code no.
	COMPONENTS	
	7. Unit A0 Chassis assembly	
	When ordering, prefix circuit reference with A0	
FS1	250 mA (time delay) (210-240 V a.c. supply)	23411-055P
	500 mA (time delay) (105-120 V a.c. supply)	23411-056X
	Fuse holder	23416-192R
	Cover for fuse holder	23416-198E
FS2	250 mA (time delay) (210-240 V a.c. supply)	23411-055P
	500 mA (time delay) (105-120 V a.c. supply)	23411-056X
	Fuse holder	23416-192R
	Cover for fuse holder	23416-198E
PLA	Mains plug filter assembly	23423-150L
	Cover for mains filter	37590-150P
Rect. 1	Rectifier bridge 1B10J20	28359-188W
SA & SB	Mains voltage selector d.p.c.o. (slider)	23467-161W
	Cover for SA and SB	37590-245S
SC	SUPPLY ON/OFF d.p.d.t. (semi-rotary)	23462-353A
	Cover	37590-246W
	Extension spindle for SC	37590-244V
SKB	EXT STD BNC 50 Ω	23443-446H
SKC	INT STD BNC 50 Ω	23443-446H
T1	Mains transformer	43490-063P
*	Cushion pad for T1	37490-263X
TR1	2N4918	28434-896Y
TR2	2N4918	28434-896Y
X1	Ring core	23635-913Z
	*Replace pad when replacing T1	
	8. Unit A1 Function board	
	When ordering, prefix circuit reference with A1	
	Complete board	44828-131B
C1	Plas 0.1μF 10% 100V	26582-799N
C2	Cer 22pF ±2.5pF 750V	26324-715T
C3	Cer 0.047μF -20+80% 25V	26383-017U
C4	Cer 0.047μF -20+80% 25V	26383-017U
C5	Elec 470μF -20+100% 16V	26423-262J
C6	Cer 0.047μF -20+80% 25V	26383-017U
C7	Tant 22μF ±20% 15V	26486-583L
C8	Cer 0.1μF -20+80% 30V	26383-031S
C9	Elec 1000μF -20+100% 6V	26423-268D
C10	Var cer 7-35pF	26847-120U
C11	Cer 0.047μF -20+80% 25V	26383-017U
C12	Elec 1000μF -20+100% 6V	26423-268D

8. Unit A1 Function board (contd.)

Circuit reference	Description	Code no.
C15	Cer 0.047µF -20+80% 25V	26383-017U
C17	Tant 6.8µF ±20% 6V	26486-560W
C18	Cer 0.047µF -20+80% 25V	26383-017U
C19	Cer 0.047µF -20+80% 25V	26383-017U
C20	Cer 0.047µF -20+80% 25V	26383-017U
C21	Plas 0.47µF 10% 63V	26582-410P
C22	Cer 10pF ±0.5pF 63V	26343-465H
C23	Tant 47µF ±20% 6V	26486-232A
C24	Tant 6.8µF ±20% 6V	26486-560W
C25	Elec 10µF -20+100% 63V	26423-215K
C26	Cer 0.001µF -20+80% 500V	26383-242P
C27	Cer 0.001µF -20+80% 500V	26383-242P
C28	Tant 22µF ±20% 15V	26486-230B
C29	Plas 0.1µF 10% 100V	26582-799N
C30	Tant 22µF ±20% 15V	26486-230B
C31	Cer 0.047µF -20+80% 25V	26383-017U
C35	Cer 0.001µF -20+80% 500V	26383-242P
C36	Cer 0.001µF -20+80% 500V	26383-242P
C37	Cer 0.001µF -20+80% 500V	26383-242P
C38	Cer 0.001µF -20+80% 500V	26383-242P
C39	Cer 0.001µF -20+80% 500V	26383-242P
C40	Cer 0.001µF -20+80% 500V	26383-242P
C41	Cer 0.001µF -20+80% 500V	26383-242P
C42	Cer 0.001µF -20+80% 500V	26383-242P
C43	Cer 0.047µF -20+80% 25V	26415-017U
C44	Cer 0.047µF -20+80% 25V	26415-017U
C45	Cer 0.047µF -20+80% 25V	26415-017U
C46	Cer 0.01µF -20+80% 100V	26383-055L
C50	Cer 0.01µF -20+80% 100V	26383-055L
C51	Tant 22µF ±20% 15V	26486-583L
C52	Tant 22µF ±20% 15V	26486-583L
C53	Cer 0.01µF -20+80% 100V	26383-055L
C54	Cer 0.01µF -20+80% 100V	26383-055L
C55	Tant 22µF ±20% 15V	26486-230B
C56	Elec 470µF -20+100% 16V	26423-262J
C57	Elec 1000µF -20+100% 16V	26415-825W
C58	Elec 1000µF -20+100% 16V	26415-825W
C59	Elec 1000µF -20+100% 25V	26415-826D
C60	Elec 1000µF -20+100% 25V	26415-826D
C61	Elec 470µF -20+100% 25V	26415-822G
C65	Cer 0.047µF -20+80% 25V	26383-017U
C66	Cer 0.047µF -20+80% 25V	26383-017U
C67	Tant 22µF ±20% 15V	26486-230B
C71	Tant 22µF ±20% 15V	26486-230B
C72	Cer 0.047µF -20+80% 25V	26383-017U
C73	Tant 22µF ±20% 15V	26486-230B

Circuit reference	Description	Code no.
	8. Unit A1 Function board (contd.)	
C74	Tant 22µF ±20% 15V	26486-230B
C75	Tant 22µF ±10% 15V	26486-230B
C76	Cer 0.047µF -20+80% 25V	26383-017U
C77	Tant 22µF ±20% 15V	26486-230B
C78	Tant 22µF ±20% 15V	26486-230B
C79	Tant 22µF ±20% 15V	26486-230B
C80	Cer 0.001µF ±10% 63V	26383-585M
C81	Cer 0.047µF -20+80% 25V	26383-017U
C82	Tant 47µF ±20% 6V	26486-232A
C100	Cer 0.047µF -20+80% 25V	26383-017U
D1	1N4148	28336-676J
D2	Z5B 5.1	28371-403N
D3	1N4148	28336-676J
D4	Z5B 5.1	28371-403N
D5	Z5B 5.1	28371-403N
D6	Z5B 5.1	28371-403N
D7	BAY 72	28337-126P
D8	1N825	28371-494Z
D9		
D10	1N5390	28349-005Z
D11	1N5390	28349-005Z
D12	1N4148	28336-676J
D13	1N4148	28336-676J
D14	1N4148	28336-676J
D15	1N4148	28336-676J
D16	1N5390	28349-005Z
D17	1N4148	28336-676J
D18	1N4148	28336-676J
D19	1N5390	28349-005Z
D20	1N5390	28349-005Z
D21	1N4148	28336-676J
D22	1N4148	28336-676J
D27	1N4004	28357-028K
D28	1N4004	28357-028K
D29	1N4004	28357-028K
D30	1N4004	28357-028K
D31	1N4004	28357-028K
D32	1N4004	28357-028K
D33	1N4004	28357-028K
D34	1N4004	28357-028K
D35	Z5B 3.0	28371-203G
D36	Z5B 4.3	28371-313T
D37	Z5B 4.3	28371-313T
D38	1N4148	28336-676J
IC1	MC 10105P	28466-105Z
IC2	MC 10231P	28462-610K
IC3	MC 10131P	28462-605R
IC4	74LS196	28464-016D

Circuit reference	Description	Code no.
	8. Unit A1 Function board (contd.)	
IC5	7472	28462-003L
IC6	741	28461-304T
IC7	74S74	28462-607K
IC8	74LS123	28468-309B
IC9	74121	28468-402S
IC10	74LS132	28469-205N
IC11 ⚠	MA150A	28469-379V
	Socket 40-pin for IC11	28488-047F
IC12	74LS90	28464-014S
IC13	74LS03	28466-346E
IC14	74145	28465-018E
IC15	74LS03	28466-346E
IC16	741	28461-304T
L2	RF choke 10 μH	23642-555G
L3	RF choke 10 μH	23642-555G
PLB, PLF, PLP	Terminal posts, (sections of 36-way strip)	23435-121J
PLQ, PLR, PLS, PLT	Terminal posts, (sections of 36-way strip)	23435-121J
	Connector link, 2-way for PLB & PLF	43129-375S

Circuit reference	Description	Code no.
R1	Carb 1MΩ 5% 1/8W	24311-945Y
R2	Carb 10MΩ 10% 1/8W	24321-885W
R4	Met film 51Ω 2% ¼W	24773-242Z
R5	Met film 200Ω 2% ¼W	24773-256S
R6	Met film 33Ω 2% ¼W	24773-237K
R7	Met film 10Ω 2% ¼W	24773-225W
R8	Met film 1kΩ 2% ¼W	24773-273A
R9	Met film 4.7kΩ 2% ¼W	24773-289W
R10	Met film 1kΩ 2% ¼W	24773-273A
R11	Met film 27Ω 2% ¼W	24773-235R
R12	Met film 180Ω 2% ¼W	24773-255V
R13	Met film 10Ω 2% ¼W	24773-225W
R14	Met film 470Ω 2% ¼W	24773-265M
R15	Met film 27Ω 2% ¼W	24773-235R
R16	Met film 180Ω 2% ¼W	24773-255V
R17	Var cer 220Ω 10% ½W	25711-546X
R18	Met film 10Ω 2% ¼W	24773-225W
R19	Met film 1kΩ 2% ¼W	24773-273A
R20	Met film 390Ω 2% ¼W	24773-263P
R21	Met film 100Ω 2% ¼W	24773-249J
R22	Met film 360Ω 2% ¼W	24773-262T
R23	Met film 10Ω 2% ¼W	24773-225W
R24	Met film 47Ω 2% ¼W	24773-241A
R25	Met film 240Ω 2% ¼W	24773-258D
R26	Met film 100Ω 2% ¼W	24773-249J

8. Unit A1 Function board (contd.)

Circuit reference	Description	Code no.
R27	Met film 510Ω 2% ¼W	24773-266C
R28	Met film 47Ω 2% ¼W	24773-241A
R29	Met film 510Ω 2% ¼W	24773-266C
R30	Met film 10Ω 2% ¼W	24773-225W
R31	Met film 200Ω 2% ¼W	24773-256S
R32	Met film 150Ω 2% ¼W	24773-253F
R33	Met film 1kΩ 2% ¼W	24773-273A
R34	Met film 510Ω 2% ¼W	24773-266C
R35	Met film 510Ω 2% ¼W	24773-266C
R38	Met film 510Ω 2% ¼W	24773-266C
R39	Met film 680Ω 2% ¼W	24773-269K
R40	Met film 510Ω 2% ¼W	24773-266C
R41	Met film 510Ω 2% ¼W	24773-266C
R42	Met film 510Ω 2% ¼W	24773-266C
R43	Met film 510Ω 2% ¼W	24773-266C
R44	Met film 510Ω 2% ¼W	24773-266C
R45	Met film 510Ω 2% ¼W	24773-266C
R46	Met film 510Ω 2% ¼W	24773-266C
R47	Met film 510Ω 2% ¼W	24773-266C
R48	Met film 510Ω 2% ¼W	24773-266C
R49	Met film 510Ω 2% ¼W	24773-266C
R50	Met film 510Ω 2% ¼W	24773-266C
R51	Met film 4.7kΩ 2% ¼W	24773-289W
R52	Var cer 10kΩ 10% 1/3W	25748-507X
R53	Met film 750Ω 2% ¼W	24773-270R
R55	Met film 10kΩ 2% ¼W	24773-297M
R56	Met film 220kΩ 2% ¼W	24773-329T
R57	Carb 2.2MΩ 10% 1/8W	24321-877J
R58	Carb 1kΩ 10% 1/8W	24321-273A
R59	Carb 1.5kΩ 10% 1/8W	24321-277U
R60	Carb 220kΩ 10% 1/8W	24321-329T
R61	Carb 220kΩ 10% 1/8W	24321-329T
R62	Carb 10kΩ 10% 1/8W	24321-297M
R63	Carb 1kΩ 10% 1/8W	24321-273A
R64	Carb 1kΩ 10% 1/8W	24321-273A
R65	Carb 1kΩ 10% 1/8W	24321-273A
R66	Carb 10kΩ 10% 1/8W	24321-297M
R67	Carb 200Ω 10% 1/8W	24321-256S
R68	Carb 10kΩ 10% 1/8W	24321-297M
R69	Var cermet 10kΩ 10% ½W	25711-543D
R70	Met film 22kΩ 2% ¼W	24773-305R
R71	Met film 680Ω 2% ¼W	24773-269K
R72	Met film 2.2kΩ 2% ¼W	24773-281Y
R73	Met film 22kΩ 2% ¼W	24773-305R
R74	Met film 4.7kΩ 2% ¼W	24773-289W
R75	Met film 2.2kΩ 2% ¼W	24773-281Y
R76	Met film 22kΩ 2% ¼W	24773-305R
R77	Met film 22kΩ 2% ¼W	24773-305R

8. Unit A1 Function board (contd.)

Circuit reference	Description	Code no.
R78	Met film 2.2kΩ 2% ¼W	24773-281Y
R79	Met film 2.2kΩ 2% ¼W	24773-281Y
R80	Met film 2.2kΩ 2% ¼W	24773-281Y
R81	Met film 2.2kΩ 2% ¼W	24773-281Y
R82	Met film 2.2kΩ 2% ¼W	24773-281Y
R83	Met film 2.2kΩ 2% ¼W	24773-281Y
R84	Met film 2.2kΩ 2% ¼W	24773-281Y
R85	Met film 2.2kΩ 2% ¼W	24773-281Y
R86	Met film 10Ω 2% ¼W	24773-225W
R87	Met film 47Ω 2% ¼W	24773-241A
R88	Met film 82Ω 2% ¼W	24773-247N
R89	Met film 560Ω 2% ¼W	24773-267R
R90	Met film 4.7kΩ 2% ¼W	24773-289W
R91	Met film 1.5kΩ 2% ¼W	24773-277U
R92	Met film 510Ω 2% ¼W	24773-266C
R93	Met film 1kΩ 2% ¼W	24773-273A
R94	Met film 3.3kΩ 2% ¼W	24773-285F
R95	Met film 1kΩ 2% ¼W	24773-273A
R96	Met film 10kΩ 2% ¼W	24773-297M
R97	Met film 100Ω 2% ¼W	24773-249J
R101	Met film 1kΩ 2% ¼W	24773-273A
R102	Met film 1kΩ 2% ¼W	24773-273A
R103	Met film 3.3kΩ 2% ¼W	24773-285F
R104	Met film 47Ω 2% ¼W	24773-241A
R105	Met film 3.3kΩ 2% ¼W	24773-285F
R106	Met film 3.3kΩ 2% ¼W	24773-285F
R107	Met film 3.3kΩ 2% ¼W	24773-285F
R108	Met film 3.3kΩ 2% ¼W	24773-285F
R109	Met film 3.3kΩ 2% ¼W	24773-285F
R110	Met film 3.3kΩ 2% ¼W	24773-285F
R111	Met film 3.3kΩ 2% ¼W	24773-285F
R112	Met film 3.3kΩ 2% ¼W	24773-285F
R113	Met film 1kΩ 2% ¼W	24773-273A
R114	Met film 1kΩ 2% ¼W	24773-273A
R115	Met film 1kΩ 2% ¼W	24773-273A
R116	Met film 1kΩ 2% ¼W	24773-273A
R117	Met film 1kΩ 2% ¼W	24773-273A
R118	Met film 1kΩ 2% ¼W	24773-273A
R119	Met film 1kΩ 2% ¼W	24773-273A
R120	Met film 1kΩ 2% ¼W	24773-273A
R123	Met film 4.7kΩ 2% ¼W	24773-289W
R124	Met film 4.7kΩ 2% ¼W	24773-289W
R125	Met film 4.7kΩ 2% ¼W	24773-289W
R126	Met film 3.3kΩ 2% ¼W	24773-285F
R127	Met film 330Ω 2% ¼W	24773-261D
R128	Met film 2.2kΩ 2% ¼W	24773-281Y
R129	Met film 3.3kΩ 2% ¼W	24773-285F
R130	Met film 330Ω 2% ¼W	24773-261D
R131	Met film 330Ω 2% ¼W	24773-261D

Circuit reference	Description	Code no.
	8. Unit A1 Function board (contd.)	
R132	Met film 3.3kΩ 2% ¼W	24773-285F
R133	Met film 1kΩ 2% ¼W	24773-273A
R134	Met film 2.2kΩ 2% ¼W	24773-281Y
R135	Met film 1kΩ 2% ¼W	24773-273A
R136	Met film 1kΩ 2% ¼W	24773-273A
R137	Met film 1kΩ 2% ¼W	24773-273A
R138	Met film 1kΩ 2% ¼W	24773-273A
R141	Met film 1kΩ 2% ¼W	24773-273A
R144	Met film 3.3kΩ 2% ¼W	24773-285F
R145	Met film 10Ω 2% ¼W	24773-225W
R146	Met film 3.3kΩ 2% ¼W	24773-285F
R147	Met film 2.2kΩ 2% ¼W	24773-281Y
R148	Met film 200Ω 2% ¼W	24773-256S
R149	Met film 10kΩ 2% ¼W	24773-297M
R150	Met film 10Ω 2% ¼W	24773-225W
R151	Met film 3.9kΩ 2% ¼W	24773-287V
R152	Met film 1kΩ 2% ¼W	24773-273A
R153	Met film 2.2kΩ 2% ¼W	24773-281Y
R154	Met film 2.2kΩ 2% ¼W	24773-281Y
R155	Met film 200Ω 2% ¼W	24773-256S
R156	Met film 1kΩ 2% ¼W	24773-273A
R157	Met film 22kΩ 2% ¼W	24773-305R
R158	Met film 2.2kΩ 2% ¼W	24773-281Y
R159	Met film 2.2kΩ 2% ¼W	24773-281Y
R160	Var cermet 2.2kΩ 10% ½W	25711-547M
R161	Met film 2.2kΩ 2% ¼W	24773-281Y
R162	Met film 10kΩ 2% ¼W	24773-297M
SA	LP FILTER	23467-157S
SB	MHz } Push-button	
SC	kHz } switch	44338-101S
SD	Hz } assembly	
	Button (stone grey)	37590-227A
SKA	INPUT 50Ω BNC	23443-406R
SKD	Edge connector 20-way	23435-056W
TR1 ⚠	40673	28459-010V
TR2	2N5179	28451-697Y
TR3	2N5179	28451-697Y
TR4	2N5179	28451-697Y
TR5	2N5179	28451-697Y
TR6	2N5179	28451-697Y
TR7	2N4258	28431-767E
TR8	2N5179	28451-697Y
TR9	2N5179	28451-697Y
TR10	2N5179	28451-697Y
TR15	BC238B	28452-781A
TR16	BC308B	28433-455R
TR17	BC308B	28433-455R
TR18	BC308B	28433-455R

Circuit reference	Description	Code no.
	8. Unit A1 Function board (contd.)	
TR19	BC308B	28433-455R
TR20	2N4258	28431-767E
TR21	2N5179	28451-697Y
TR22	BC239C	28452-771P
TR25	BC238B	28452-781A
TR26	2N5448	28433-838Z
TR27	2N5448	28433-838Z
TR28	2N5448	28433-838Z
TR29	2N5448	28433-838Z
TR30	2N5448	28433-838Z
TR31	2N5448	28433-838Z
TR32	2N5448	28433-838Z
TR33	2N5448	28433-838Z
TR34	BC238B	28452-781A
TR35	BC238B	28452-781A
TR36	BC238B	28452-781A
TR37	BC239C	28452-771P
TR43	BC239C	28452-771P
TR44	BC239C	28452-771P
TR45	BC239C	28452-771P
TR46	MM3001	28458-406T
TR47	BC239C	28452-771P
TR48	BC239C	28452-771P
TR49	BC239C	28452-771P
	Heat sink (for TR46)	28488-448H
	Top screen	35902-450L
	Bottom screen	35902-451J
	9. Unit A2 Display board	
	When ordering prefix circuit reference with A2	
	Complete board	44828-132K
	Buttress moulding, red, supporting display board	37590-141G
C1	Tant 47μF ±20% 6V	26486-232A
D1	Numeric display	28624-216R
D2	Numeric display	28624-216R
D3	Numeric display	28624-216R
D4	Numeric display	28624-216R
D5	Numeric display	28624-216R
D6	Numeric display	28624-216R
D7	Numeric display	28624-216R
D8	Numeric display	28624-216R
IC1	74LS47	28465-020H
LP1	OVERFLOW	28624-109M
LP2	GATE	28624-109M
LP3	EXT STD	28624-109M

Circuit reference		Description	Code no.
		9. Unit A2 Display board (contd.)	
R1		Met film 47Ω 2% ¼W	24773-241A
R2		Met film 47Ω 2% ¼W	24773-241A
R3		Met film 47Ω 2% ¼W	24773-241A
R4		Met film 47Ω 2% ¼W	24773-241A
R5		Met film 47Ω 2% ¼W	24773-241A
R6		Met film 47Ω 2% ¼W	24773-241A
R7		Met film 47Ω 2% ¼W	24773-241A
		10. Unit A10 Oscillator (standard)	
		When ordering, prefix circuit reference with A10, for use with Version 52431-311S	
		Complete board	44827-563E
C1	†	Cer 22pF 5% 50V	26343-469N
C2		Var cermet 4.5-15pF	26847-115H
C3		Cer 100pF 2% 50V	26343-477V
C4		Cer 220pF 2% 50V	26343-481S
C5		Cer 0.01μF -20+80% 100V	26383-055L
C6		Cer 0.01μF -20+80% 100V	26383-055L
D1		BB142	28381-097W
R1		Met film 47kΩ 2% ¼W	24773-313H
R2		Met film 47kΩ 2% ¼W	24773-313H
R3		Met film 2.2kΩ 2% ¼W	24773-281Y
R4		Met film 2.2kΩ 2% ¼W	24773-281Y
R5		Met film 68kΩ 2% ¼W	24773-317N
R6		Met film 680Ω 2% ¼W	24773-269K
R7		Met film 100kΩ 2% ¼W	24773-321L
TR1		BC238B	28452-781A
TR2		BC173C	28452-771P
XL1		10 MHz AT cut	28312-047U

11. Unit A11 Oscillator (temperature compensated)

For use with Version 52431-312W

Complete assembly 44990-273N

12. Unit A12 Oscillator (oven controlled)

For use with Version 52431-313D

Complete assembly 44990-195Z

Note ...

Units A11 and A12 are factory tested units, set up and calibrated under very accurately controlled conditions. If an internal fault is diagnosed replace assembly as per the code number given above, which identifies a complete, factory tested, direct replacement unit.

MISCELLANEOUS MECHANICAL PARTS

13. Item numbers refer to Fig. 1.

Order without prefix.

Item	Description	Code no.
1	Knob	41149-058W
2	Window	37490-397X
	Window retainer	35902-442H
3	Top cover	35902-308Y
4	Side rail	34900-424M
5	Flange	37590-221X
6	Spring washer	31119-045W
7	Arm	37590-222M
8	Rear plate fixing	35902-219T
9	Rear foot	37590-225B
10	Cap	37590-219M
11	Boss	37590-220P
12	Handle	35902-220W
13	Rear frame	35890-048B
	Strip, r.f. seal (2 off - trapped between top, lower cover and rear frame)	35902-969W
14	Rear panel assembly, marked	35902-436K
	Blanking plate	35902-440A
	Locking plate	35902-441Z
15	Handle moulding	37590-226K
16	Lower cover	35902-309N
17	Front panel assembly, marked	41700-224Z
18	Front frame	35890-047R
19	Stud	37590-223C
20	Foot	37590-224R

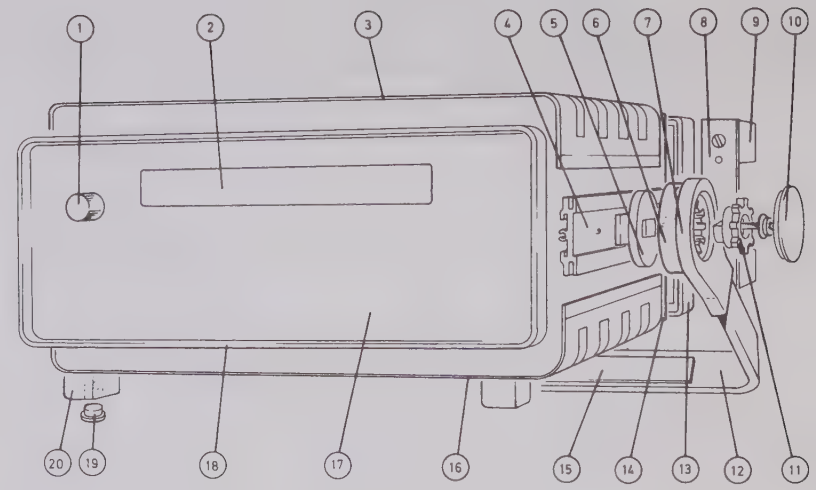

Fig. 1 Miscellaneous mechanical parts : identification.

Chapter 7

SERVICING DIAGRAMS

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1 Circuit notes
1 Component values
2 Symbols

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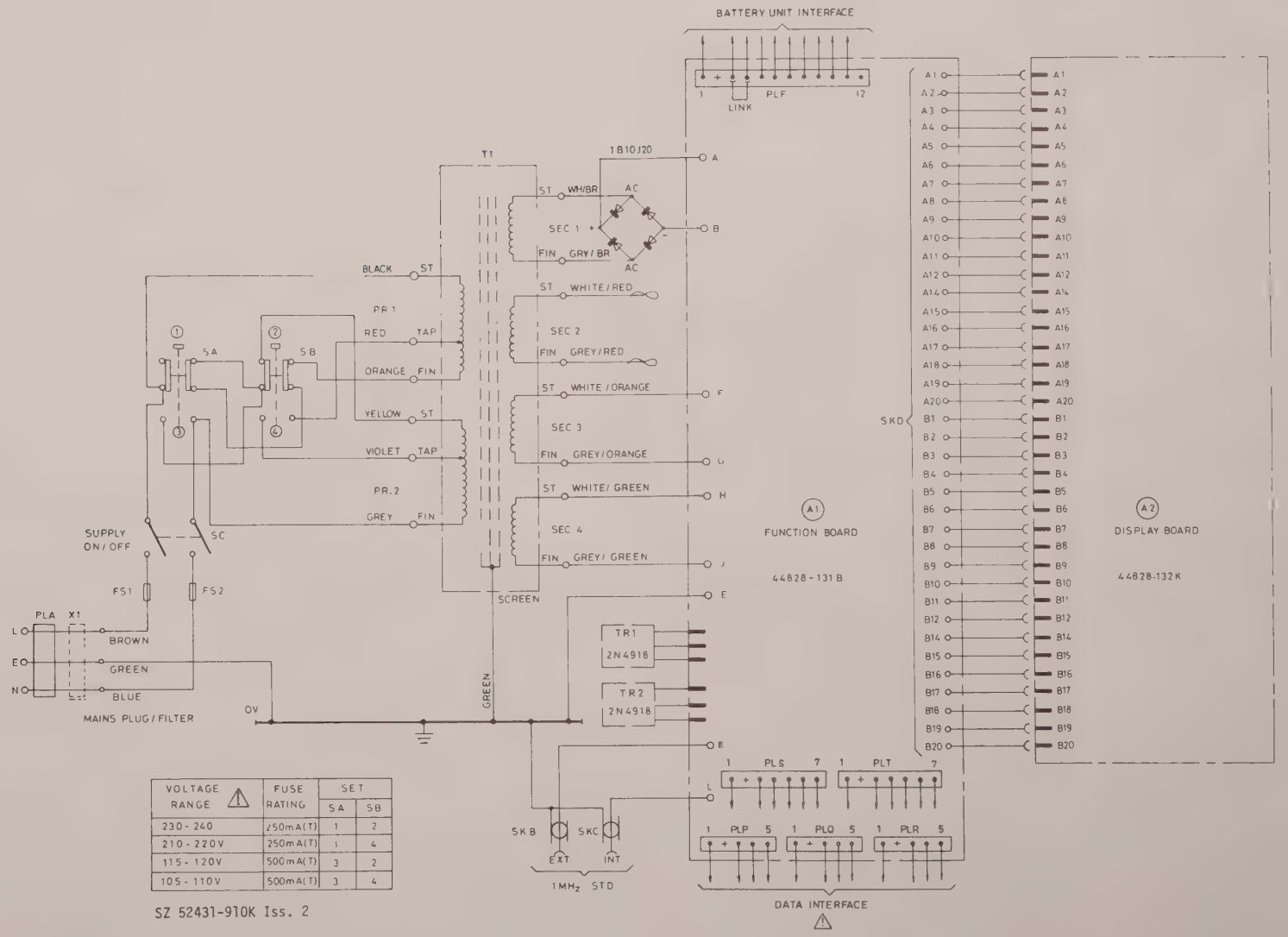
CIRCUIT NOTES

Component values

1. Resistors : No suffix = ohms, k = kilohms, M = megohms
   Capacitors : No suffix = microfarads, pF = picofarads
   Inductors : μ = microhenries
   SIC : Value selected during test, nominal value shown.

Symbols

2. Generally in accordance with BS 3939



VOLTAGE RANGE ⚠	FUSE RATING	SET	
		SA	SB
230 - 240	250mA(T)	1	2
210 - 220V	250mA(T)	1	4
115 - 120V	500mA(T)	3	2
105 - 110V	500mA(T)	3	4

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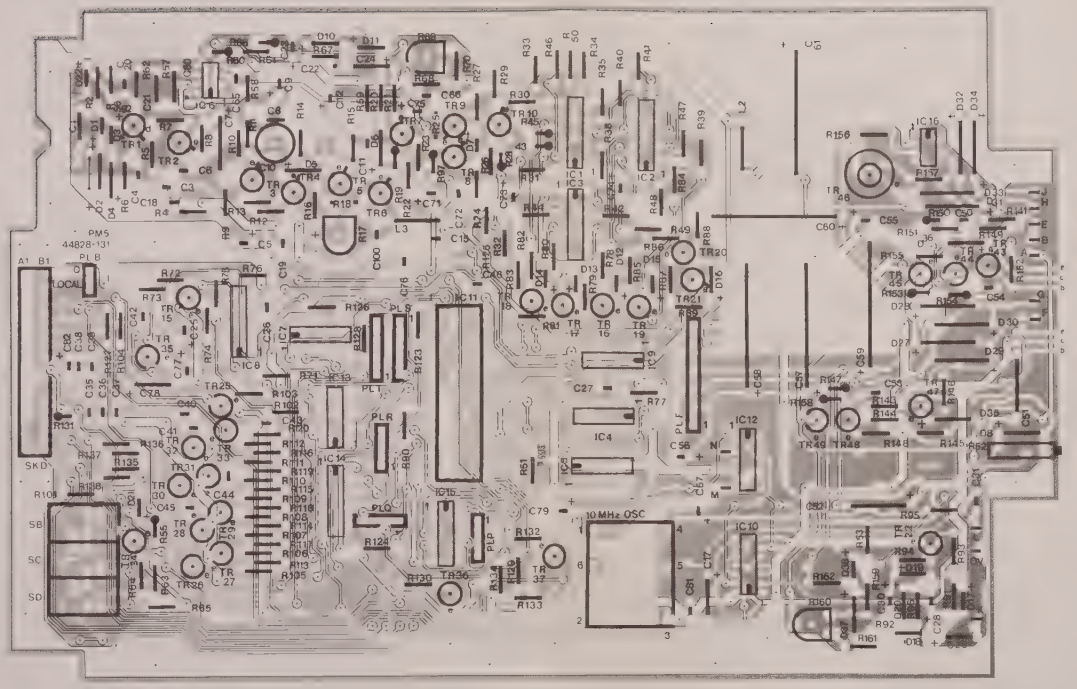
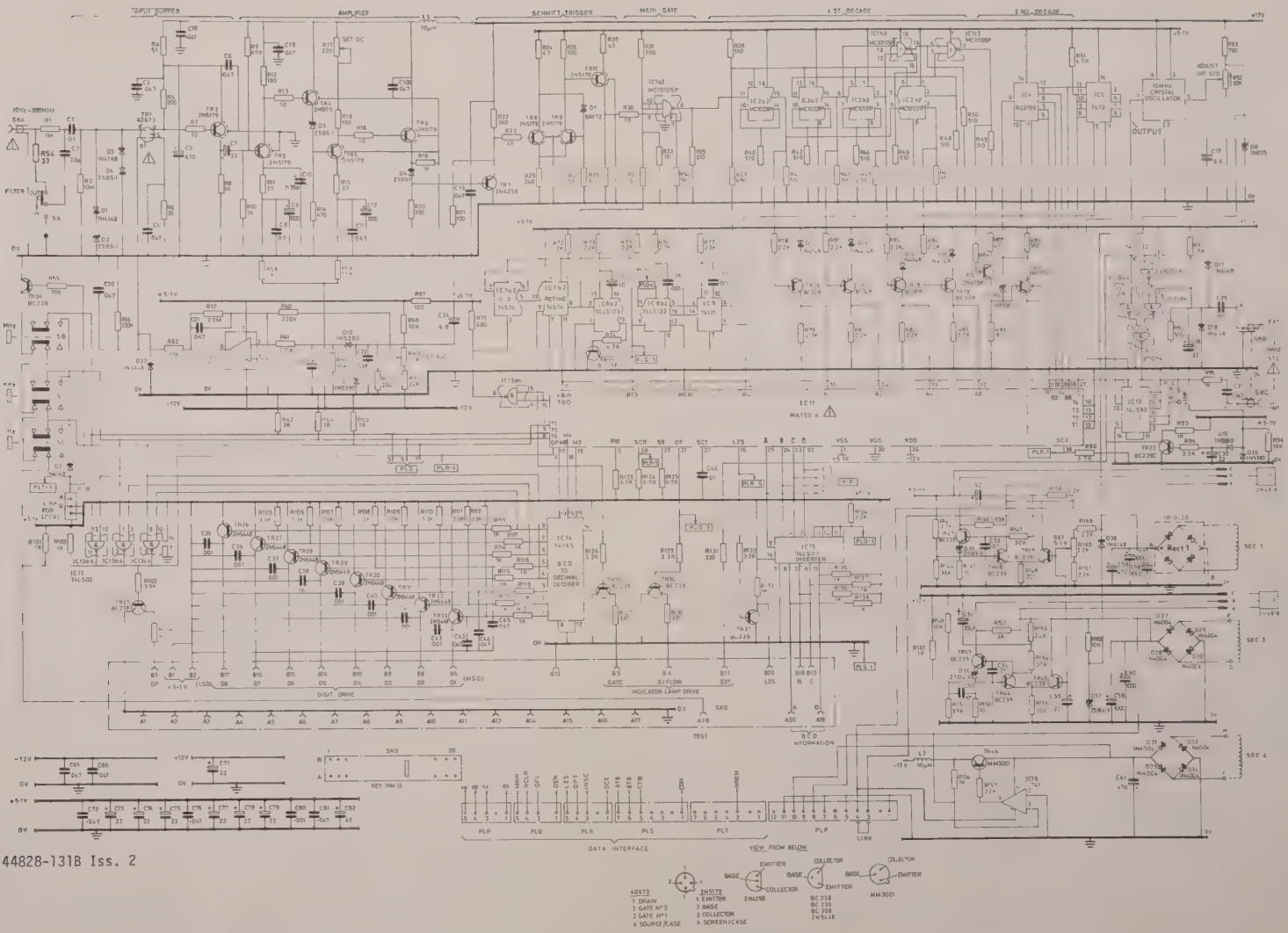
2431A Interconnection diagram, A0



Function board, A1 : component layout

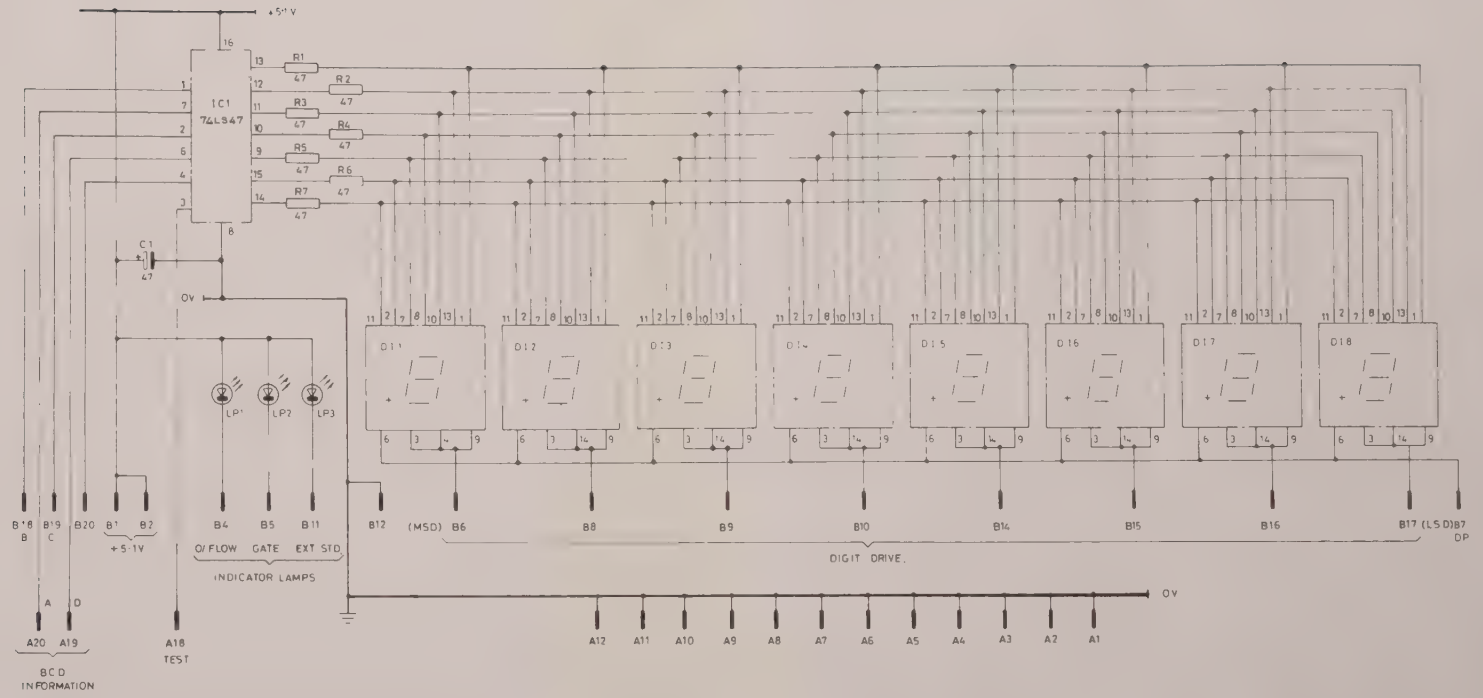


SZ 44828-131B Iss. 2

Function board, A1 : circuit diagram

Display board, A2 : component layout

Fig. 4



SZ 44828-132K Iss. 2

Fig. 5

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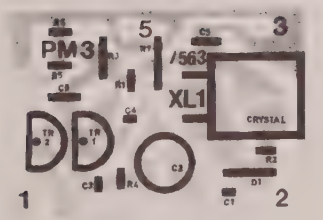
Display board, A2 : circuit diagram



10 MHz oscillator, A10 : component layout

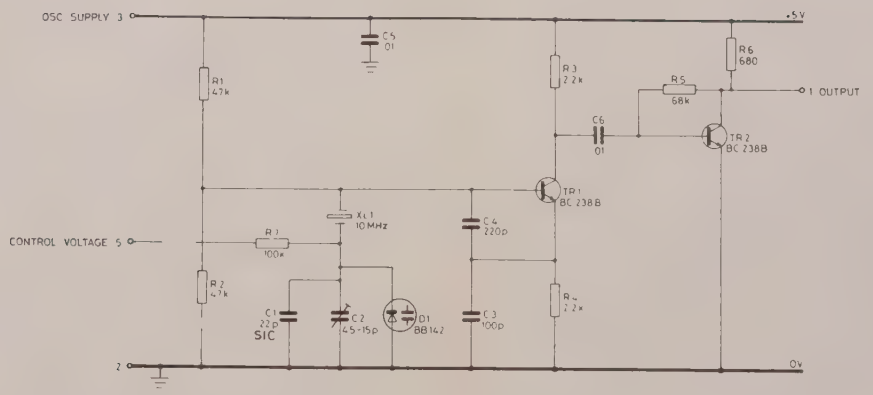


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Fig. 7

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10 MHz oscillator, A10 : circuit diagram

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